United States Department of the Interior

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Behavior and Habitat Use of Coaster Strain Brook Trout Stocked in Whittlesey Creek

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May 11, 2005

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Introduction

Stocks of anadromous or lake dwelling brook trout in the Lake Superior basin are severely depleted. Populations of these fish, regionally called "coasters" or "rock trout", probably numbered more than 120 prior to settlement of the Lake Superior region by Europeans, but are now reduced to a handful of tiny remnants (Newman and Dubois 1996). In *A rehabilitation plan for brook trout in Lake Superior* (Newman *et al.* 2003) the Great Lakes Fishery Commission proposes a lake-wide strategy for rehabilitation of coaster stocks in their native habitats.

Whittlesey Creek has been identified as historic coaster habitat (Newman and DuBois 1996). A partnership of personnel from the Whittlesey Creek National Wildlife Refuge (WCNWR), Ashland Fishery Resources Office (AFRO), and Wisconsin Department of Natural Resources (WIDNR) has developed an action plan for an experiment to establish a self-sustaining brook trout population in Whittlesey Creek that exhibits a migratory life history. Components of the experiment include stocking various life stages of basin-native brook trout stocks, enactment of protective regulations, and habitat improvements (USFWS and WIDNR 2003). This radio-telemetry study was designed to determine behavior and habitat use of two strains of hatchery-reared, adult brook trout stocked into Whittlesey Creek.

Objective

To determine behavior (distribution and movement) and habitat use of two Lake Superior strains (Tobin Harbor and Siskiwit River) of brook trout *Salvelinus fontinalis* introduced as hatchery-produced adults into Whittlesey Creek.

Methods

Two strains of wild brook trout from putative coaster populations were radio-tagged and stocked in this study. Both strains (Tobin Harbor and Siskiwit River) originated from Michigan waters of Lake Superior at Isle Royale National Park. The fish, ages 3 and 4 were selected from broodstock reared by the Iron River National Fish Hatchery (IRNFH). Total lengths of the fish ranged from 394 to 499 mm. Weights ranged from 883 g to 2,257 g. All fish were apparently in good health.

Radio transmitters were surgically implanted in 27 fish at the IRNFH on July 22, 2003, employing techniques similar to those described in Newman *et al.* (1999) and Newman (2000). All fish to be tagged were anesthetized with MS 222 before the tags were surgically implanted. When the fish were fully anesthetized, a surgical scalpel was used to cut an opening about 18 mm long down the midline of the belly about 30 mm behind

the pectoral fins. The initial incision went through the skin and partially through the abdominal muscle layer. The tip of a hemostat was then inserted and the back of the jaws used to complete a "blunt incision" through the remaining muscle layer into the body cavity. The radio transmitter was then inserted into the body cavity. After the transmitter was inserted three sutures (4/0 monofilament) were used to close the incision with the antenna protruding. The final suture was also wound around the antenna to help "lock" the antenna in place, to prevent movement within the incision and to ensure retention of the transmitter. The incision was coated with triple-antibiotic ointment and the fish were then returned to the fresh water raceway where they were held for recovery and observation until they were stocked on August 9, 2003. One fish died about one week after the surgery (probably as a result of the surgery). The remaining 26 fish comprised of 7 males and 6 females of the Siskiwit strain, and 7 males and 6 females of the Tobin Harbor strain, were stocked in apparent good health.

We used internal radio-transmitters (Model 1835) manufactured by [2]Advanced Telemetry Systems (ATS), Inc. of Isanti, Minnesota. Transmitters were guaranteed to last 433 days and expected to last up to twice that length of time. This model transmitter was selected because it would function at least through the fall 2004 spawning season and possibly through fall 2005. Each transmitter broadcast on an individual frequency in the range from 153.034 to 153.868 MgHz. The transmitters were preprogrammed to transmit continuously for the entire battery life. Transmitters had antennae lengths of 22.86 cm (9 in) and weighed 14 g, in all cases less than the 1.25% of body weight recommended by Winter *et al.* (1978).

Fish were trucked from Iron River NFH to Whittlesey Creek the morning of August 9, 2003. The fish were stocked at two locations (Figure 1), 15 at the upstream site (release point 2) and 11 at the Wickstrom Road bridge crossing (release point 1). Stream temperature was 8.2^{o}C and the river was low and clear. A barrier made of 1 inch (2.54 cm) chicken wire was placed about 0.45 km from Lake Superior to confine the fish to the stream for one week in the hope that it might provide some degree of imprinting to the stream habitat.

No major precipitation events occurred during the four months following the release, so stream conditions remained unusually low and clear. Discharge rates recorded at the Whittlesey Creek USGS Gauging Station for the entire period ranged from 17 to 22 cfs. A sand plume at the river mouth presented an extremely difficult, shallow water barrier to out migration. Daytime water temperatures in Chequamegon Bay at the river mouth (<10 cm depth) were found to be as high as 24^{0}C (August 13) and 25^{0}C (August 22).

In addition to the 26 radio-tagged fish, 54 fish from the same lot without transmitters were stocked. These 54 fish were equally represented by strain and sex and were stocked at the same two locations as the radio-tagged fish. Each of these fish received a yellow, individually numbered external Floy t-bar tag marked with U.S. Fish and Wildlife Service, Ashland, WI.

[2] The mention of trade names or commercial products in this report does not constitute endorsement or recommendation for use by the Federal government.

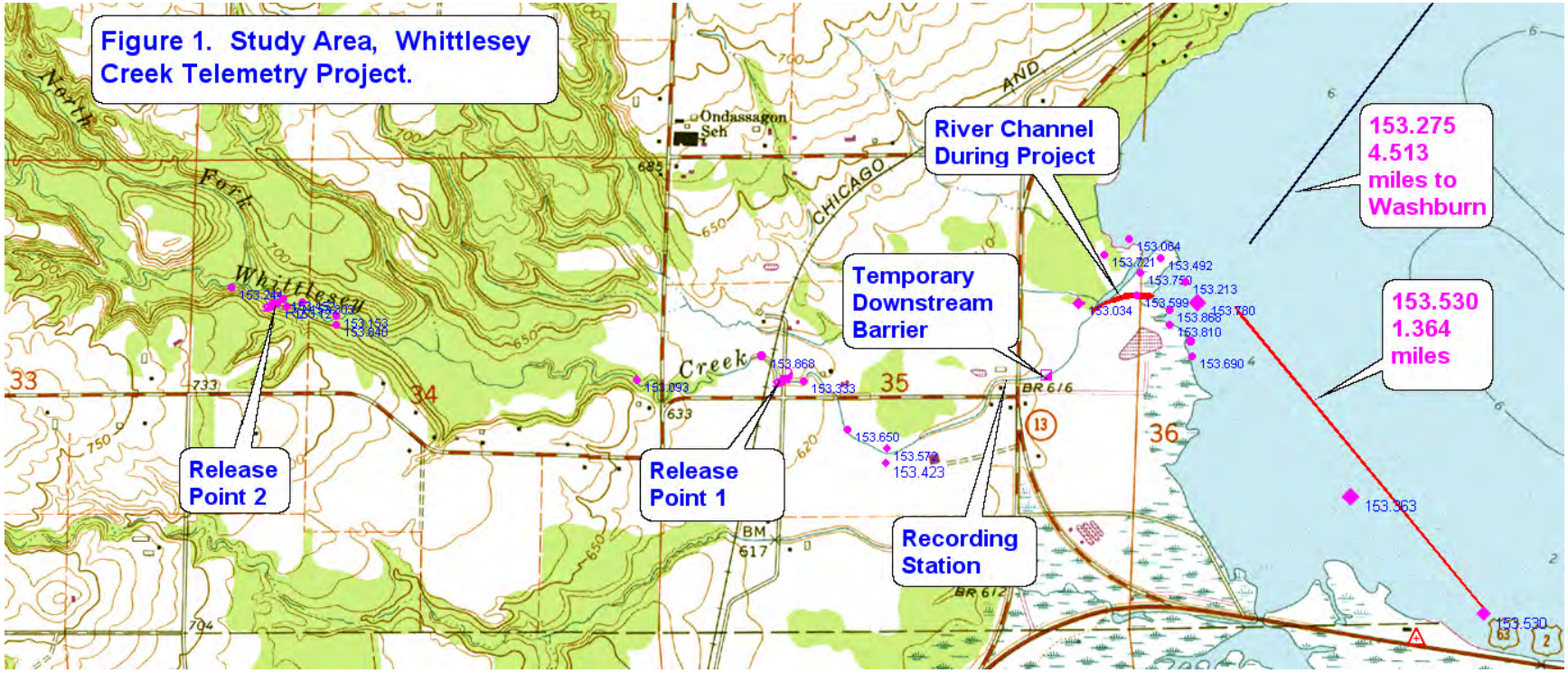

Figure 1. Study Area, Whittlesey Creek Telemetry Project.

We used [2]ATS Model R2000 receivers to locate transmitters. We utilized active search methods (foot, vehicle, boat, and aircraft) and a stationary data logging station with an integrated receiver and ATS Model D5401 data logger. A portable, hand-held three element Yagi antenna was used for active long range searches and two stationary 4-element Yagi antennae were used at the fixed station.

The stationary data logging unit was set up on the stream bank 0.66 km upstream from the stream mouth at Lake Superior. This site was selected because it was the nearest location to the mouth where electrical power was available and a landowner was present to provide a measure of security for the equipment. The purpose of this station was to record movement of fish past the location and to help define fish movement in and out of the stream, particularly in fall when fish might return to the river.

Stationary antennas attached to an 8 m long aluminum pole were secured to a tree located along the bank, three meters from the creek. The site was at a bend in the river and one antenna was directed upstream and the other downstream at roughly 90^{o} angles to each other. This configuration was intended to increase the range of transmitter detection.

The receiver and data logger were housed in a plastic cooler to protect the units from the elements. An extension cord ran from a quarter-sized hole on the side of the cooler to a continuous power source. A temporary battery backup was available within the data logger if the initial power source failed. During cold weather, a light bulb (varying from 20-60 watts) was turned on in the cooler to keep the temperature above the manufacture's recommendation of 0°F. A tub of desiccant was placed in the cooler to reduce moisture.

All transmitter frequencies were programmed into the receivers and data logger. The data logger continually scanned through each frequency, with a 2 second pause at each frequency. A full cycle of all transmitters took a minimum of 52 seconds to complete. The transmitters emitted a signal every 1.7 seconds and would be detected if encountered. If a positive signal was received, the receiver would remain on the frequency for a total of 8 seconds. This delay procedure provided assurance that a signal was valid and helped identify false detections caused by interference It is possible that fish could move past the roughly 300 m detection distance of the logging station before a full cycle through all frequencies could occur.

One of the transmitters was used to test receiving equipment function and range. With both the stationary and hand-held receivers and associated antennae, the reception range varied based on traffic, weather, vegetative cover, and electrical interference. The reception distance of the stationary receiver was variable depending on conditions, but typically 150 meters in either direction (upstream and downstream) of the logging station. The reception distance of the hand-held receiver ranged from 50 m to as much as 800 m depending on conditions and location of the transmitter.

Once a week, the data was downloaded from the logging station to a laptop computer and a DOS-based program provided by ATS. The logging station was checked frequently to prevent the memory chip from exceeding its capacity limit. The data was imported into

Microsoft Excel for access and interpretation. The data logger operated continuously until March 28, 2004 except for a few occasions. Power was periodically lost and backup power was depleted on one occasion. Data may also have been lost when the data logger filled its memory with false signals and interference, preventing data from being recorded for a 36 hour period.

A variety of tracking techniques were used. On August 21, in-stream hand-held monitoring began along specific stretches of Whittlesey Creek. When fish were detected, modified antennas were used to pin point their location in a given habitat. A modified "ping pong paddle" antenna received a range of 3-10 meters and an even narrower range of 0.5 to 3 meters was available with a single wire "stub" antenna attached directly to the receiver. Three boat surveys were also employed parallel to the shoreline of Chequamegon Bay using the hand-held equipment mentioned above. Boat surveys were done on August 13, October 6 and November 10, 2003. The coverage area was the shoreline of Chequamegon Bay from the east end of Ashland to Houghton Point, a distance of about 23 km.

On three separate occasions, aerial surveys (using a Cessna 172 G) were conducted to locate fish in Chequamegon Bay. A Yagi antenna was mounted on each wing strut of the plane and an ATS receiver in the cockpit scanned a range of frequencies from 152.000 to 153.999 MgHz. The aerial tracking was provided courtesy of the Bad River Band of Lake Superior Chippewa. Aerial surveys provided excellent information on the general location of several fish around the river mouth. This information was subsequently used to more precisely locate fish with the hand held equipment. Since aerial locations indicated the general area of a transmitter, precise coordinate information was not generated and is not reported.

Results

The barrier was not effective in preventing downstream migration because of bed erosion around the structure.

Surveys conducted with the hand held receiver and the records from the data logger indicated some downstream movement of 25 of the 26 radio tagged fish. Active tracking conducted between August 21 and October 20, 2003 resulted in detection of every fish within Whittlesey Creek or at the sand bar/shallow water complex at the stream mouth at least once. We observed only two live fish during tracking activities.

During the survey on August 21, we began to note that many of the fish located did not appear to be moving. We began to actively search for mortalities and recovered one radio tag in Whittlesey Creek. On August 22, we recovered a second radio tag from the stream and a kayaker returned two transmitters that were found on the sand flat near the mouth of Whittlesey Creek. We recovered two transmitters on August 28, six on September 6, and three on September 11. During this time we confirmed another mortality by locating (but not recovering) a transmitter in a wetland where no surface water existed.

Boat surveys provided limited information on fish locations. During the boat survey on August 13, we detected four transmitter signals from locations on the sand flat at, or near, the mouth of Whittlesey Creek. No signals were detected in Chequamegon Bay. During the October and November boat surveys several fish/transmitters that had not been previously detected during active tracking, were located in the shallows along the shoreline of Chequamegon Bay near the mouth of Whittlesey Creek (Figure 1). Only one fish/transmitter was located in the open water of Lake Superior, that near Washburn, about 7.26 km from the mouth of Whittlesey Creek in about 5 m of water. It was located at the same spot twice during October, and again on April 1, 2004. It did not move after the initial detection and we determined that the fish was dead.

By October 1, 18 transmitters had been recovered from various locations along the stream or the sand flat at the mouth. In addition, six transmitters that remained stationary were located (but not recovered) in areas where mortality was virtually certain (buried in sand, in wetland, or in debris piles). Including the transmitter near Washburn, we could account for 25 of 26 fish/transmitters. One fish that was recorded by the data logger on August 10, 2003 was never located again. It may be at large, the transmitter may have failed, or the fish may have been removed from the project area. Locations where transmitters were recovered or located are shown in Figure 1.

A total of 23 of the 26 fish were detected with the stationary data logging equipment. Two of the three fish not detected were located near the stream mouth using hand held tracking equipment. The third fish/transmitter was located upstream and apparently never ventured downstream as far as the logging station. In conjunction with the hand held equipment, we were able confirm the downstream movement of 15 fish past the logging station. Most were detected within the first two weeks following release.

In summary, 11 transmitter fish were found dead in the stream upstream of the data logger. A total of 15 fish moved (or were carried) downstream past the data logger. Of the 15, 13 died on the extensive sand flats and shallows at, and around the river mouth. The fate of one is unknown and one moved or was carried to the location in Lake Superior near Washburn.

Of the 15 transmitters that moved downstream past the data logger, nine were from fish stocked at the upstream site and six were stocked at Wickstrom Road bridge. Females outnumbered males nine to six and Tobin Harbor fish outnumbered Siskiwit River fish ten to five. We do not know whether these fish moved downstream of their own volition, floated downstream dead or were carried by predators or scavengers.

We received limited information to date on the movement or survival of the fish with Floy tags. One was found dead and another was returned by a fisherman who caught it at the mouth of Fish Creek. One Floy tagged fish was encountered during the September 8-16, 2003 stream electrofishing survey conducted by WIDNR and AFRO. The fish was captured downstream of the confluence of Whittlesey Creek and the North Fork and upstream of Ondossagon Road.

No major precipitation events occurred from June through September 2003. Stream flow remained stable and water was always clear. Daily discharge rates recorded at the Whittlesey Creek USGS Gauging Station from June through September ranged from 17 to 22 cfs. Daytime water temperature in Chequamegon Bay at the mouth of Whittlesey Creek was 24^{0}C on August 13 and 25^{0}C on August 22. Without high water events, fish entry and exit from the river was extremely difficult.

Discussion

The intent of this study was to describe behavior (movement to and from Lake Superior and distribution) and habitat use of individual fish in Whittlesey Creek and Lake Superior. We prepared to track fish during open water season from August 2003 until late fall 2004. However, due to the rapid and high mortality of fish with transmitters there was little opportunity to observe long term fish movement in Whittlesey Creek and none in Lake Superior.

We noted a general tendency for downstream movement of fish/transmitters, particularly during the first few weeks following release. We are reluctant to assign too great a significance to this movement because we have no way of knowing whether the movement was active swimming, floating with the current, or even being carried by a predator.

Mortality of stocked brook trout with transmitters likely resulted from a number of factors. We believe the principal problem resulted from the inability of fish to exit Whittlesey Creek. Due to the lack of any significant precipitation event during fall of 2003, water level remained at base flow throughout the study period. Through mid September, the stream mouth lacked a defined channel and flowed across a large sand flat. The lack of a defined channel or stream mouth hindered the ability of fish to exit or enter the stream. The sand flat at the mouth measured 150 m long by 10-200 m wide and water depth ranged from 1-4 cm.

In August, water temperatures in Chequamegon Bay reached at least 24 ^{o}C. This water temperature is above the temperature preference of brook trout (5-20 ^{o}C) reported by Becker (1983). Even if fish had been able to easily move between Whittlesey Creek and Chequamegon Bay, it is likely that the warm water in Chequamegon Bay would have deterred fish from leaving the cooler stream.

The clear water within Whittlesey Creek and the size of the fish may have increased vulnerability to predation in the stream. While we can not confirm whether a fish was killed by a predator or scavenged, we noted abundant sign and scat of mink, otter and black bear on the stream. We also observed bald eagles, osprey and many gulls around the mouth. Three transmitters were recovered at what appeared to be mink “feeding stations” on logs extending into the stream. In one case, two transmitters were found on the same log (Figure 2).

Figure 2. Transmitters found on possible mink “feeding station”. Arrows point to transmitters.

All stocked fish were raised in a hatchery. Their behavioral responses to natural occurrences such as predators are unknown. Within the first few days after stocking, two fish were observed in shallow water without cover. In contrast, those believed to be alive a few weeks later were usually detected under very thick cover and seemed to be extremely wary. Although fish appeared healthy upon release, it is not known how quickly they acquired natural behaviors such as foraging for food or choosing habitat for cover. Their stress levels following surgery and then relocation to Whittlesey Creek may have added to the mortality, however, similar surgical techniques and equipment were employed in studies of adult Lake Nipigon strain fish at Grand Portage (Newman *et al* 1999) and wild, Tobin Harbor native fish (Newman 2000) at Isle Royale, and survival rates were nearly 70% in the wild one year following the surgical procedure.

We initially expected to be able to detect directionality of movement of the fish through the use of a two antennae data logging system. However, we learned that our equipment did not feature that capability. Therefore, we were only able to determine that a particular fish/transmitter had been within range of the recording station. Confirming that

it had passed required detection with the hand held receiver. The data logging station provided good information on fish movement when it functioned properly.

Two fish passed the logging station undetected. There are several possible explanations for this occurrence. The fish may have moved past the station while data was being downloaded to the laptop computer, a time when no signals can be recorded. The fish may have passed through the roughly 300 m detection zone too quickly to be detected. It took 52 seconds for the system to cycle through 26 transmitters and when the test transmitter was in place the cycle took at least 62 seconds. Finally, there were several occasions when power was lost or memory was filled and no data was recorded.

Acknowledgements

We would like to thank the Wisconsin DNR for purchasing the radio telemetry tags for this project, the Bad River Band of Lake Superior Chippewa for aerial tracking, and numerous volunteers, primarily from the Wild Rivers Chapter of Trout Unlimited. Volunteers carried fish by bucket into remote locations, assisted in radio tracking and observed fish behavior in the stream. Without these contributions this project would not have been possible.

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Whittlesey Creek Brook Trout Telemetry Project. Individual Fish Stocked .

Frequency in MgHz	Stocked at Site:	*Strain	Sex	Length (mm)	Wt. (gms.)	Fin Clip	Status on December 1, 2003	Comments:
153.303	Site 2	S	M	460	1719	RV	**Dead in stream *	Found 9/18/03
153.530	Site 2	S	F	450	1724	RV	Dead in lake. Near Short Bridge.	Downstream 8/16/03 Found in lake 9/10/03 (shallow)
153.840	Site 2	S	M	444	1694	RV	Dead in stream	Live on 8/21/03, found dead 9/18/03
153.183	Site 2	S	F	444	1282	RV	Unknown	Downstream 8/10/03
153.124	Site 2	S	M	435	1646	RV	Dead in stream	Found in stream 8/24/03
153.244	Site 2	S	F	394	1090	RV	Dead in stream	Found in stream 8/28/03
153.423	Site 2	S	M	428	1446	RV	Dead in stream	Not recovered
153.034	Site 2	S	F	422	1482	RV	Dead in stream	Found in swamp 10/6/03
153.492	Site 2	T	M	439	1416	LV	Dead in stream	Found dead at mouth 9/11/03
153.363	Site 2	T	F	431	1299	LVA	Dead in Lake.	Downstream 8/21/03,2 Aircraft location near long bridge
153.213	Site 2	T	M	494	1469	LV	Dead in stream	Saw live 8/22/03, found 9/10/03
153.064	Site 2	T	F	445	1786	LV	Dead in stream 9/11/2003	Downstream 9/2/03 found at mouth 9/10
153.750	Site 2	T	M	433	1488	LV	Dead in stream	Found at mouth 8/22/03
153.690	Site 2	T	F	440	1429	LV	Dead in stream	Downstream 8/9/03 found at mouth 9/10
153.452	Site 2	T	M	476	1940	LV	Dead in stream	Found 8/21/03
153.650	Site 1	S	M	440	1673	RV	Dead in stream	Downstream 8/11/03, Found 9/17/03
153.153	Site 1	S	F	409	1025	RV	Dead in stream	Found 8/28/03
153.093	Site 1	S	M	430	1540	RV	Dead in stream	Not recovered.
153.333	Site 1	S	F	403	883	RV	Dead in stream	Found 8/21/03
153.599	Site 1	S	M	499	1772	RV	Dead in stream	Downstream 8/10/03, found 9/11
153.780	Site 1	T	F	434	1238	LV	Dead in stream	Downstream 8/10/03 found 9/11
153.721	Site 1	T	M	422	1228	LVA	Dead in stream	Downstream 8/9/03 found 9/17
153.572	Site 1	T	M	482	1768	LV	Dead in stream	Not recovered
153.810	Site 1	T	F	432	1520	LV	Dead in stream	Found at mouth 9/10
153.275	Site 1	T	F	434	1313	LVA	Dead in lake off Washburn	Downstream 8/10/03 Not recovered
153.868	Site 1	T	M	479	1744	LV	Dead in stream	Found at mouth 10/2/03